CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF CIVIL ENGINEERING

DEPARTMENT OF INDOOR ENVIRONMENTAL AND BUILDING SERVICES ENGINEERING

HVAC IN AN OFFICE BUILDING

PRACTICAL PART: HVAC SYSTEM IN AN OFFICE BUILDING

Bc. DOMINIKA CALDERWOOD

2018/2019

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TECHNICAL REPORT

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1. THE PROJECT

This project is carried out at a building permit level with certain extensions.

2. THE BUILDING

2.1. Location

The office building is located in a Pankrác neighborhood in Prague 4.

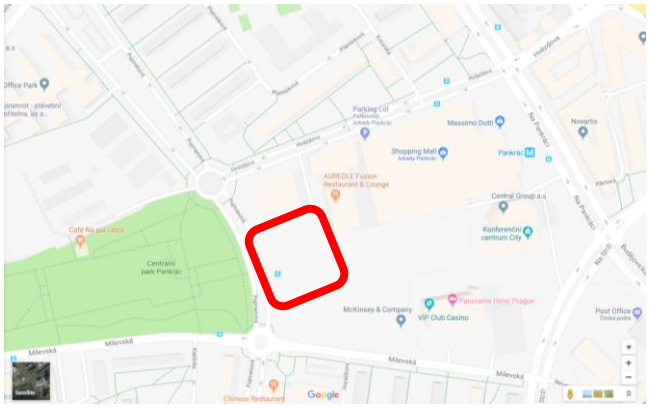

Figure 1 : Location marked on the map [website: https://www.google.com/maps]

2.2. Building

The newly constructed building has nine above ground floors primarily serving as office space with some space dedicated to a restaurant and retail business space, and three underground floors which serve mainly as a parking area. The structure itself is a combination of reinforced concrete skeleton and monolith. The building structure is mostly enclosed by a modern glass curtain wall, providing a contemporary, open feel for the users. Certain walls, especially on the ground floor, are brick or concrete monolith with continuous exterior insulation.

The ground floor offers two retail stores, a restaurant and a large atrium. All of the other above ground floors serve as office areas with conference rooms, server rooms, kitchens and bathrooms.

3. SOURCES

3.1. Drawing documentation

Drawings used for this thesis were acquired from the architecture studio CUBOID ARCHITEKTI s.r.o. The acquired data consists of floor plans, section views, exterior views and assemblies' specifications.

3.2. Project

This technical report is based on the project which consists of the following parts:

Calculations:

1. Air flow volumes calculation
2. Air-handling units' design
3. Heat loss/heat gain calculations
4. Air distribution products' design
5. Hydraulic calculation – duct sizing, pressure loss
6. Air duct noise assessment, silencers' design

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4. BASIC INPUT DATA

4.1. Climate data

Region according to the Czech Technical Standard 06 0210/2005	Prague
Altitude above sea level	282,8 m
Winter design day temperature - t_e	-12°C

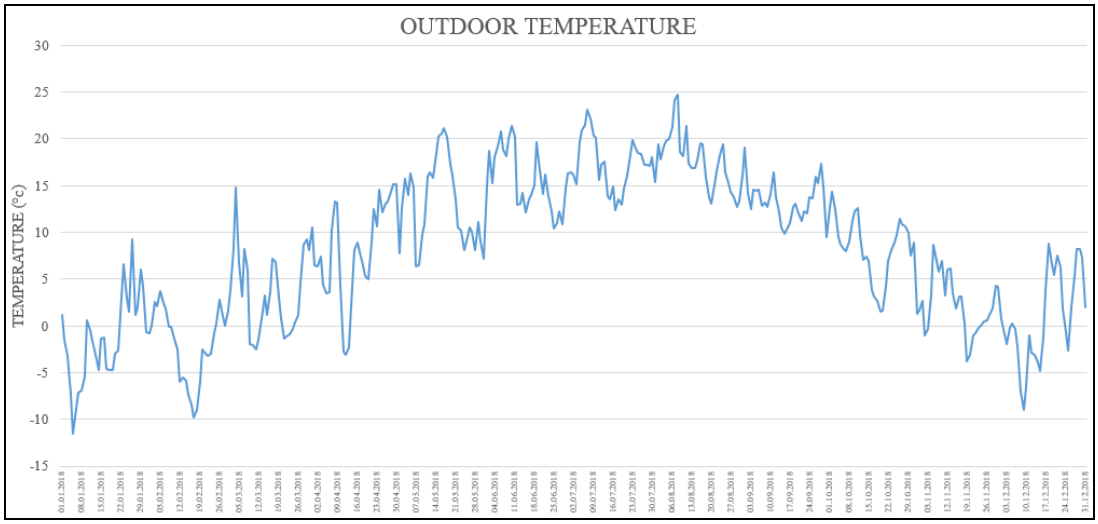

Figure 2: Outdoor temperature throughout the year [DesignBuilder – weather data for Prague]

4.2. Required winter indoor temperatures

- Occupied rooms 20°C
- Bathrooms 22°C
- Corridors 18°C

4.3. Outdoor air properties

- winter: t_e = - 12 °C, humidity = 90 %
- summer: t_e = 32 °C, enthalpy 56 kJ/kg

4.4. Occupancy

Occupancies were calculated for specific rooms and converted to people/m^2.

The open offices were divided into individual enclosed 2-5 person offices based on the façade modules. Office occupancy was calculated accordingly to their inner volume, based on the fact that every worker will need about 20m^3 of volume.

In the case of the restaurant, the usable area was multiplied by the height of the room and the volume was then divided by 6 m^3/person.

For meeting rooms, the number of occupants was based on the architectural concept, the furniture choice, etc.

5. REQUIRED HYGIENIC LIMITS

5.1. Concept

- Balanced pressure system in: offices, meeting rooms, retail, corridors
- Negative pressure system in: kitchen, dining room, sanitary facilities
- CO2 limit: 1000ppm
- Exhaust air from bathrooms and kitchen cannot be reused for recirculation.

5.2. HVAC associated noise

Noise caused by the HVAC system will be reduced using the following methods:

- Flexible attachment of all rotating elements
- Silencers in ducts
- Using insulated flex duct near all air distribution elements

After the installation of the HVAC system, a noise test of all individual air handling units will be carried out. A protocol with results will be presented during the final inspection.

A noise assessment calculation is a separate chapter in the calculation part of this project (see calculation no.6)

5.3. Pollution

There is no significant source of pollution inside the building.

6. ENVIRONMENTAL IMPACT

6.1. Emissions

The exhaust air from all HVAC systems will be directed to the roof where it will be vented to the outside. Usage of this building will not cause any dangerous, harmful, or pestering emissions in any significant amount.

6.2. Waste production

HVAC system will produce waste in air filters. Those will be replaced on a regular basis and disposed of in a recommended way.

6.3. Noise

HVAC system design deals with inner noise production and its regulation by using silencers. Their design is a separate chapter in the calculation part of this project. The building does not produce external noise that would exceed any hygienic limits. By placing the air-handling units on the roof the source of noise is very distant from inhabited area.

7. FIRE PROTECTION

This HVAC project follows all rules related to fire prevention and fire containment.

Every floor is a separate fire section and the ducts penetrating more floors will have the necessary fire dampers in every branch. If the duct continues from 1 fire section to another, there is a fire damper placed in the duct.

8. CALCULATION OF AIRFLOW VOLUMES

For offices the airflow volumes were calculated based on the figure used nowadays of 38m^3/h/person. Every office floor was divided into an expected office layout and every small office had a number of workers assigned to it.

For other rooms (corridors, archives, storage rooms, kitchenettes, copy rooms) where people are not expected to spend a long period of time in, the airflow volume is based on 0,5/h exchange rate. In the basements the rooms are being ventilated in 0,1/h rate.

For rooms with a smell/vapor sources (sanitary facilities) airflows were calculated based on following per-unit set airflows.

Water closet	50	m^3/h
Sink	30	m^3/h
Shower	150	m^3/h
Urinal	25	m^3/h
Cleaning closet	50	m^3/h

The airflow volume for the restaurant was calculated using a software for kitchen AC design by Atrea. Specific appliances from the kitchen design were entered into the program.

9. DESCRIPTION OF INSTALLED SYSTEMS

9.1. HVAC no.1 – A1 offices, meeting rooms etc.

Air flow volume rates:

Supply: 20 320 m^3/h

Exhaust: 20 320 m^3/h

The pressure loss:

Supply: 330 Pa

Exhaust: 330 Pa

This system serves the offices in the top left part of the building with offices oriented to the north, west and north-east.

The primary air-handling unit, located on the roof, delivers pre-heated or pre-cooled minimum fresh air volume to all offices, meeting rooms and other rooms belonging to that part of the building. In every office and meeting room there is a local fan-coil delivering the necessary cooling and heating load.

Every room has a temperature sensor to automatically moderate the inner environment. The temperature sensor gives users the ability to set a desired temperature themselves if it differs from the default settings.

Every office and meeting room has its own fan-coil producing heat and cold in the capacity needed for the individual space. There is no other source of heat or cold, such as radiators, etc.

The fan-coils placed in the offices recirculate certain volume of air to deliver the necessary heat or cold.

Primary air is pre-cooled to 25°C in summer or pre-heated to 20°C in winter. It is connected into the output part of the fan-coil where it mixes with the heated or cooled air from the fan-coil and then continues to the distribution element placed in the room.

During the winter season the AHU on the roof uses heat recovery which preheats the exterior input air to 8,8°C. The AHU then heats the air to 15°C, Then the air needs to be humidified to 80 %. The AHU then heats the air to the desired 20°C.

During the summer season the AHU precools the exterior input air to 25°C.

All psychometric changes are shown in the Mollier diagram in the calculation part of the thesis.

The design of the fan inside the AHU is based on the hydraulic calculations where the actual pressure loss is calculated. The fan is designed to create a sufficient inner pressure to cancel out the loss of pressure.

9.2. HVAC no.2 – A2 Offices, meeting rooms etc.

Air flow volume rates:

Supply: 20 091 m^3/h

Exhaust: 13 171 m^3/h

The pressure loss:

Supply: 400 Pa

Exhaust: 400 Pa

This system serves the offices in the bottom part of the building with offices oriented to the south and west. The primary air-handling unit, located on the roof, delivers pre-heated or pre-cooled minimum fresh air volume to all offices and other rooms belonging to that part of the building. In every office there is a local fan-coil delivering the necessary cooling and heating load.

Every room has a temperature sensor to automatically moderate the inner environment. The temperature sensor gives users the ability to set a desired temperature themselves if it differs from the default settings.

Every office and meeting room has its own fan-coil producing heat and cold in the capacity needed for the individual space. There is no other source of heat or cold, such as radiators, etc.

Primary air is pre-cooled to 25°C in summer or pre-heated to 20°C in winter. It is connected into the output part of the fan-coil where it mixes with the heated or cooled air from the fan-coil and then continues to the distribution element placed in the room.

During the winter season the AHU on the roof uses heat recovery which preheats the exterior input air to 4,32°C. The AHU then heats the air to 15°C, then the air needs to be humidified to 80 %. The AHU then heats the air to the desired 20°C.

All psychometric changes are shown in the Mollier diagram in the calculation part of the thesis.

The design of the fan inside the AHU is based on the estimated value of the pressure loss. The fan is designed to create a sufficient inner pressure to cancel out the loss of pressure.

9.3. HVAC no.3 – B offices, meeting rooms etc.

Air flow volume rates:

Supply: 24 447 m^3/h

Exhaust: 24 447 m^3/h

The pressure loss:

Supply: 400 Pa

Exhaust: 400 Pa

This system serves the offices in the right part of the building with offices oriented to the north, east and south-east.

The primary air-handling unit, located on the roof, delivers pre-heated or pre-cooled minimum fresh air volume to all offices, meeting rooms and other rooms belonging to that part of the building. In every office and meeting room there is a local fan-coil delivering the necessary cooling and heating load.

Every room has a temperature sensor to automatically moderate the inner environment. The temperature sensor gives users the ability to set a desired temperature themselves if it differs from the default settings.

Every office and meeting room has its own fan-coil producing heat and cold in the capacity needed for the individual space. There is no other source of heat or cold, such as radiators, etc.

The required airflow volume has been calculated to supply 38 m3/h of fresh air to every user in 1 hour or 0,5/h exchange rate was used.

Primary air is pre-cooled to 25°C in summer or pre-heated to 20°C in winter. It is connected into the output part of the fan-coil where it mixes with the heated or cooled air from the fan-coil and then continues to the distribution element placed in the room.

During the winter season the AHU on the roof uses heat recovery which preheats the exterior input air to 8,8°C. Then the air needs to be humidified to 80 %. The AHU then heats the air to the desired 20°C.

During the summer season the AHU precools the exterior input air to 25°C.

All psychometric changes are shown in the Mollier diagram in the calculation part of the thesis.

The design of the fan inside the AHU is based on the hydraulic calculations where the actual pressure loss is calculated. The fan is designed to create a sufficient inner pressure to cancel out the loss of pressure.

9.4. HVAC no.4 – Sanitary facilities, corridors, egress stairs, restaurant's utility area

Air flow volume rates:

Supply: 4 460 m3/h

Exhaust: 10 435 m3/h

The pressure loss:

Supply: 400 Pa

Exhaust: 400 Pa

One AHU placed on the roof handles both supply and exhaust air.

The airflows for the sanitary facilities were calculated based on the required extract airflows stated in chapter 7.

The AHU serves the sanitary facilities as well as the main corridor alongside the lobby, the egress stairs in a non-emergency situation and the restaurant's utility area on the 1st floor.

In the sanitary facilities there is an extract distribution element in every room. Round ceiling valves of several sizes, installed in the drop ceiling, will be used as distribution elements.

Apart from serving the corridors, the egress stairs and the utility area of the kitchen, the supply partially serves the sanitary facilities. Due to the negative pressure created in sanitary facilities, the majority of the needed airflow is then taken from the office area A2 through wall vents and door grilles.

The duct system is opening into one vertical duct leading to the roof.

The air volumes needed for the corridor and stairs were calculated based on the required air exchange rate of 0,5/h.

The stairs are considered an evacuation route in case of an emergency. Therefore, in case of a fire, system no.4 is going to be shut off and the HVAC no.11 will be activated to ensure positive pressure inside the stairwell.

The required psychometric changes in the AHU are:

winter 1) heat recovery to 15 °C. 2) humidifying 3) heating to 26 °C

summer 1) cooling to 22 °C

The exhaust air in this system is polluted and therefore recirculation is not desirable.

There is going to be a silencer segment placed in the duct right after the output from the AHU.

9.5. HVAC no.5 – Garages- Carbon monoxide elimination

Air flow volume rates:

Supply: 21 920 m^3/h

Exhaust: 19 730 m^3/h

The pressure loss:

Supply: 400 Pa

Exhaust: 400 Pa

The system serves the underground garage floors. The main purpose of this system is to eliminate the harmful CO gas, produced by cars. A detailed calculation of CO production and the necessary airflow volumes was executed in the calculation part of the thesis. See calculations part 1.

The AHU is placed in the engine room 401 on the 1st basement floor. The AHU handles both the supply and exhaust and in winter preheats the exterior air to 8°C.

9.6. HVAC no.6 – Basements

Air flow volume rates:

Supply: 18 835 m^3/h

Exhaust: 16 750 m^3/h

The pressure loss:

Supply: 400 Pa

Exhaust: 400 Pa

HVAC system for the basements both supplies and extracts air from the all the rooms but garages located on the underground floors. Because of the character of the rooms with minimum usage, the air exchange rate in most of these rooms was set at 0,1/h to ensure only the minimum air exchange. If the room was expected to be occupied on a regular basis, then rate of 0,5/h was designed.

The same HVAC system serves the engine rooms on the 1st basement floor. The air exchange rate for those rooms was set at 4/h.

All these rooms will be vented with 8°C air in the winter to ensure temperatures around 5°C after compensating for the heat loss due to heat transfer through the wall. In the summer the supply air will not be modified therefore a 32°C air will be supplied.

The winter psychrometric change, which is heat recovery with additional heating, is shown in the calculation part of the thesis.

The AHU is placed in the engine room 401 on the 1st underground floor.

9.7. HVAC no.7 – Restaurant and kitchen

Air flow volume rates:

Supply: 11 420 m^3/h

Exhaust: 13 150 m^3/h

The pressure loss:

Supply: 400 Pa

Exhaust: 400 Pa

For the kitchen area, an exhaust hood was designed using a software from the company Atrea. The cooking area was modeled and individual appliances were entered into the program. Exhaust hood size and airflow volume was determined using this program. An air handling unit located on the roof was selected.

The same AHU also handles the dining room area. The airflow volume has been calculated for the occupancy of 2x50 people/h. One person demands 50 m^3/h of fresh air.

Both the kitchen and the restaurant are kept in negative air pressure to prevent polluted air leakage.

9.1. HVAC no.8 – Lobby

There is a separate system dedicated to the lobby area. The lobby will be occupied only in its bottom part and the system is therefore designed to supply enough air to heat or cool the first 3-4 metres of space. The supply airflow was set at 3000 m3/h. There is a small air-handling unit in the engine room on the 1st basement floor that heats or cools the air. It is only a supply AHU. The extract is solved with wall grilles in the roof of the lobby which are connected to an exhaust plug fan. The airflow through the plug fan does includes the amount of air that is supplied to the corridors alongside the lobby. The total exhaust airflow is 4590m3/h.

The supplied air always has a lower temperature than the designed temperature of the lobby to ensure the desired flow pattern. Air will be slowly distributed through the large area vent and it should stay near the ground before it warms up and rises towards the roof.

The air-handling units were designed based on the required air-flow and an estimated pressure loss.

9.1. HVAC no.9 – Retail space 1

Air flow volume rates:

Supply: 1480 m^3/h

Exhaust: 1480 m^3/h

The pressure loss:

Supply: 300 Pa

Exhaust: 300 Pa

This system serves the retail space 1 located on the 1st floor in the left top part of the building with walls oriented to the north and the west.

The air-handling unit, located in the engine room 401, delivers pre-heated or pre-cooled minimum fresh air volume to the space using anemostats.

The retail space is also equipped with door air curtains, which will be a secondary source of heat if necessary.

Supply air is pre-cooled to 23°C in summer or pre-heated to 25°C in winter. During the winter season the AHU in the engine room 401 uses heat recovery which preheats the exterior input air to 6°C. The AHU then heats the air to the desired 23°C.

During the summer season the AHU pre-cools the exterior input air in the heat recovery section to 29°C. The AHU then cools the air to the desired 23°C.

All psychometric changes are shown in the Mollier diagram in the calculation part of the thesis.

The design of the fan inside the AHU is based on the estimated pressure loss.

9.1. HVAC no.10 – Retail space 2

Air flow volume rates:

Supply: 1080 m^3/h

Exhaust: 1080 m^3/h

The pressure loss:

Supply: 300 Pa

Exhaust: 300 Pa

This system serves the retail space 2 located on the 1st floor in the right top part of the building with walls oriented to the north and the east.

The air-handling unit, located in the engine room 401, delivers pre-heated or pre-cooled minimum fresh air volume to the space using anemostats.

The retail space is also equipped with door air curtains, which will be a secondary source of heat if necessary.

Supply air is pre-cooled to 23°C in summer or pre-heated to 25°C in winter. During the winter season the AHU in the engine room 401 uses heat recovery which preheats the exterior input air to 6°C. The AHU then heats the air to the desired 23°C.

During the summer season the AHU precools the exterior input air in the hear recovery section to 29°C. The AHU then cools the air to the desired 23°C.

All psychometric changes are shown in the Mollier diagram in the calculation part of the thesis.

The design of the fan inside the AHU is based on the estimated pressure loss.

9.2. HVAC no.11 – Stairs in emergency

Air flow volume rates:

Supply: 25 000 m^3/h

The pressure loss:

Supply: 150 Pa

Exhaust: 150 Pa

This system serves the stairs in the state of fire emergency. This HVAC system consists of two air handling units located on the roof which would supply the stairwells with fresh air during fire evacuation. The stairs were considered to be a type C egress corridor. The stairs would be supplied with an air exchange rate of 15/h. This air would create a sufficient positive pressure inside the space and it would prevent the smoke from getting into the stairwell area.

No psychometric changes designed. The AHUs only consist of plug fans.

The air is distributed via a straight duct with wall vents on each floor.

10. HVAC DUCT ELEMENTS

10.1. Air distribution products

All products used in this project are available online in the catalogues of various manufacturers. Certain large rectangular ducts would be custom made. Prevailing manufacturers are Systemair, Mandík and Atrea.

10.1.1. Elements used in offices, meeting rooms

Whirling outlets and linear diffusers are the supply elements designed for offices.

All offices have a glass façade that causes overheating of the space in the summer. Therefore, linear diffusers Hella (Systemair) placed alongside the façade were designed. The airflow will be directed straight down to continue along the façade and eliminate the heat radiation from the façade. The length of these diffusers differs based on what type of office they are in. Generally, the lengths 700mm, 1000mm, 1200mm and 1500mm are used. The length was primarily adjusted to the width of the office to cover the façade length evenly. The linear diffusers take approximately 50% of the supply airflow volume. The velocity of the air along the façade is higher than the comfortable level, but people are not expected to occupy the area right by the façade.

The other 50% of the airflow volume is distributed using a whirling outlet placed in the ceiling in the center of the room. The whirling outlet has blades that ensure an optimal flow pattern.

Both the linear diffusers and whirling outlets have plenum boxes.

The drop ceiling in the floors 2-9 has a clear height of 2,85m.

The offices are equipped with fan-coil units by Flex group manufacturer.

Used fan-coil types: GEKO FLEX 62/51/11/31/ and GEKO CASETTE CB1.

The fan-coils are installed between the ceiling slabs and the drop ceilings.

Wall and ceiling grilles were used for the extraction. The air volume that is being recirculated by fan-coil is extracted through a vent NOVA-F in the drop ceiling. This outlet is placed close to the entrance.

The supply ducts to the offices are always equipped with a constant airflow regulator and an attenuator, both manufactured by Mandík.

10.1.2. Elements used in corridors, stairwells, kitchenettes, archives, server rooms, sanitary facilities, restaurant's utility area

Due to small airflows disc valves TVOM and TVPM by Mandík were designed for these premises. All these spaces have a drop-down ceiling, which serves as a lay-in surface for the disc valves. For higher airflows

which occur especially in the sanitary facility on the 1st basement floor the whirling outlets/anemostats VVPM (Mandík) were designed.

Majority of rooms with TVOM and TVPM disc valves have a negative or positive air pressure and so a door or wall grille was designed to supply or extract air. Door grilles are marked as D.G. in the drawings.

10.1.3. Elements used in kitchen

An exhaust/supply hood Variant (Atrea) 3200x2200 mm was designed for the kitchen. It shelters the cooking island in the centre of the room. The airflow through this hood was calculated at 5165 m3/h. The exhaust hood has 4 supply inlets and 2 extract outlets. In the kitchen there is also a rectangular duct with duct mounted grilles which extract another 2035 m3/h. All the kitchen distribution elements have built-in grease filters. Ducts in the kitchen are not covered by a drop-down ceiling.

10.1.4. Elements used in restaurant and retail spaces

VVPM 400/500/600 anemostats were used in these premises. These elements serve for both the supply and extract. They ensure the ideal airflow direction and mixing.

10.1.5. Elements used lobby

2 large-area vents VPVM 400 (Mandík) were designed for the lobby. The round vent version was selected based on the character of the space. For extract NOVA-A grilles were selected. They are located in the roof part of the lobby.

10.1.6. Elements used in garages and basements

Duct mounted NOVA-B grilles were designed.

10.2. Door air curtain

In the entrances to the lobby, the retail spaces and the restaurant there will be door air curtains to reduce the heat loss through the doors, which are expected to be open regularly.

Air curtains installed in:

Rooms 1.102/ 1.103/ 1.104 and entrances to the lobby

VCF-B-150-E-...EC air curtains by MultiVac were used.

10.3. Airflow control regulators

Every office room has an airflow regulator RPM-K (Mandík) on the supply duct. By using them a constant airflow should be ensured. These regulators create noise which is then reduced by attenuator SMR-50 (Mandík)

Attenuators are designed to minimize the noise produced by the HVAC system. They prevent the noise from spreading to the surrounding area.

Every air handling unit has 4 attenuators, 1 on each duct leading to the unit. Those are designed to minimize the noise created by the air handling unit. Systemair attenuators were designed.

Attenuators' design is a separate calculation part of the project.

10.4. Pressure loss in ducts

In this project the pressure loss is calculated for the critical/longest duct branch from AHU 1. The critical branches start on the roof and continue all the way down to the 2nd floor. For all other branches the duct size was determined based on the velocity and airflow.

Air-handling units for which the pressure loss was not calculated in detail, the fan is designed to handle an estimated pressure loss with added surplus.

10.5. Duct material

For most of the system rigid metal ducts are used; either a rectangular duct (for high airflow volumes) or a circular duct for smaller airflow volumes near the distribution element. Both are made out of steel sheet with zinc coating. Near the distribution products (whirling air outflow outlet, grilles/vents or linear diffusers) the duct switches to a flex duct that allows an easy and precise connection. The flex duct also partially eliminates the noise produced by the HVAC system.

Duct size was determined based on a calculation of airflow and required velocity. Velocity was usually between 2-5 m/s for the end sections in rooms and 5-8 m/s in main ducts.

10.6. Duct tracing

All HVAC ducts in the above ground floors excluding the kitchen are placed in the plenum space between drop ceilings and ceiling slabs. Ducts in underground floors are placed under the ceilings but they are not covered.

The ducts on roof, placed above the roof assembly, are insulated to minimize possible heat loss or heat gain.

The drop ceilings and shafts have access panels at critical points where routine maintenance will be common or expected.

This project contains a material schedule of the 2nd floor A1 HVAC system. See the calculation part no.7.

11. AIR-HANDLING UNITS

All units were designed in the calculation part of this thesis, see the calculations part 2. CIC Hřebec software and Atrea software were used during the design. The units are located in the engine rooms either on the roof or on the 1st basement floor.

Both indoor and outdoor versions of air-handling units were designed. The outdoor casing was added to the AHUs placed outside of the engine room on the roof.

List of AHUs

Offices, meeting rooms, archives, kitchenettes, copy rooms, server rooms in A1

- AHU no.1 (see drawing Engine room 4)
    - Supply/exhaust: 20 320 m^3/h
    - Manufacturer: CIC Hřebec
    - Type: HL25

Offices, meeting rooms, archives, kitchenettes, copy rooms, server rooms in A2

- AHU no.2 (see drawing Engine room 1)
    - Supply: 20 091 m^3/h
    - Exhaust: 13 171 m^3/h
    - Manufacturer: CIC Hřebec
    - Type: HL25

Offices, meeting rooms, archives, kitchenettes, copy rooms, server rooms in B

- AHU no.3 (see drawing Engine room 2)
    - Supply/exhaust: 24 447 m^3/h
    - Manufacturer: CIC Hřebec
    - Type: HL25

Sanitary facilities, corridors, egress stairs, restaurant's utility area

- AHU no.4 (see drawing Engine room 5)
    - Supply: 4460 m^3/h
    - Exhaust: 10 435 m^3/h
    - Manufacturer: CIC Hřebec
    - Type: HL12.5

Garages- CO elimination

- AHU no.5 (see drawing Engine room 3)
    - Supply: 19 735 m^3/h
    - Exhaust: 21 920 m^3/h
    - Manufacturer: CIC Hřebec
    - Type: HL25

Basement

- AHU no.6 (see drawing Engine room 3)
    - Supply/exhaust: 18835 m^3/h
    - Exhaust: 16750 m^3/h
    - Manufacturer: CIC Hřebec
    - Type: HL20

Restaurant/kitchen

- AHU no.7 (see drawing Engine room 1)
    - Supply: 11 420 m^3/h
    - Exhaust: 13 150 m^3/h
    - Manufacturer: Atrea
    - Type: Duplex 15100 Basic

Lobby

- AHU no.8a /no.8a
    - Supply/exhaust: 3000/4590 m^3/h
    - Manufacturer: CIC Hřebec
    - Type: HL3.25 / HL 5

Retail 1

- AHU no.9
    - Supply/exhaust: 1480 m^3/h
    - Manufacturer: Atrea
    - Type: 2400 Duplex Basic

Retail 2

- AHU no.10 (see drawing Engine room 3)
    - Supply/exhaust: 1080 m^3/h
    - Manufacturer: Atrea
    - Type: 1400 Duplex Basic

Emergency HVAC

- AHU no.11
- AHU no.12
    - Supply: 12 000 m^3/h
    - Supply: 13 000 m^3/h
    - Manufacturer: CIC Hřebec
    - Type: 2x HL12.5
    - Description: in use only during a fire emergency

12. ENERGY CONSUMPTION

For running the HVAC system, the voltage of 230/400 V and the frequency of 50 Hz is needed.

13. REQUIREMENTS FOR INSTALLATION

During the coordination with other systems, the HVAC supplier will specify all requirements and connections in detail. Sewage, heating, cooling, DHW, electrical, the construction and fire protection will be taken into consideration while coordinating. In these technical specifications are stated the most important connections rising from the system's design. More specific requirements for air-handling units are stated in the calculation part of this project.

13.1. General contractor- construction

The construction has to allow the installation of HVAC system and must install the drop ceilings after the ducts and other pipes and products are in place.

The contractor has to build the necessary wall/ceiling penetration holes according to the drawings.

The contractor has to build the necessary access panels.

13.2. Plumbing

All heating and cooling coils, and humidifiers and dehumidifiers need a condensation pipe with siphon leading to sewer.

Cooling coils and humidifiers demand a water supply connection.

13.3. Cooling

Provides needed cooling capacity.

Cooling coils in all units demand cooling water supply.

Temperature gradient for HVAC cooling system set is 6/12 °C. Cooling system has to provide water of this temperature to all fan-coils and AHUs.

13.4. Heating

Provides needed heat supply.

Heating coils in all units and door air curtains demand heating water supply.

Temperature gradient for HVAC heating system set to 90/70 °C. Heating system has to provide water of this temperature to all fan-coils and AHUs.

13.5. Electricity

The electrical system has to provide a continuous supply of power to the AHUs, fans and other electrically powered parts.

The electrical system provides the required amperage, voltage and wattage.

The system provides protection against atmospheric electricity.

The system provides protection against static electricity.

The system provides protection against touch voltage.

The installation of the system complies with all manufacturers' requests.

The installation of the system complies with ČSN 73 0872.

The system has a safe and manual way of disconnecting from all power in case of a routine inspection or cleaning.

The system allows for the complete regulation of the AHUs.

14. ASSEMBLY INSTRUCTIONS

Instructions for assembly are the subject of the next step in the project documentation which will be created by the supplier of HVAC system. It is necessary to provide (a):

- flexible hold for all rotating elements
- duct hangers
- correct assembly and connection of electrically conductive parts
- thermal and fire insulation according to the requirement of the project
- thorough and consistent covering of air terminals and units during unrelated works, sanding plaster boards, putting down cement floors etc.
- system to avoid of condensation and pollution of equipment
- airtight sealing of penetrations in the building structures

15. REFERENCES

15.1. Norms, standards, decrees followed

- Decree no. 268/2009 Sb. Technical requirements for construction.

- ČSN 73 0548 Calculation of thermal load of air-conditioned spaces

- ČSN EN 12831-1 Energy performance of buildings - Method for calculation of the design heat load - Part 1: Space heating load, Module M3-3

- ČSN 12 7010 Design of ventilation and air conditioning systems - General regulation

15.2. Initial source of data

15.2.1. Architecture studio CUBOID ARCHITEKTI s.r.o

For the purposes of this thesis, architectural drawings owned by Cuboid studio were used.

15.3. Websites

https://www.qpro.cz/Psychrometricke-vypocty-Strana-5

https://www.tzb-info.cz/

https://csnonline.agentura-cas.cz/

http://www.asio.cz/

16. LIST OF FIGURES